Sarasate: A Strong Representation System for Network Policies

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Motivation

- Managing networking policies remains hard.
  - Has to fully understand policy.
  - SDN makes it more difficult if someone was not involved in coding.
- Managing relational database is remarkably easier.
  - self-explaining and common understanding.
  - for non-programmers with little expertise.

Can we provide network policy management experience comparable to that on a database?

Basic Policies and Operations

Policy Table represents a policy by conditional table.

P_1	dest	path	
	1.2.3.4	x	x=[ABC]
	y	z	y≠1.2.3.5∧y≠1.2.3.4

P_1: a policy specifies static route and filters.

P_2	dest	path	flag	
	1.2.3.4	[ABC]	u	u=1
	5.6.7.8	[ABC]	u	u≠1
	1.2.3.4	[AC]	v	v=1
	5.6.7.8	[AC]	v	v≠1

P_2: traffic balancer.

P_3	dest	path	
	1.2.3.4	x	x=[ADC]

P_3: specify static route for 1.2.3.4.

P_1 join P_2

$P_1 \bowtie P_2$	dest	path	flag	
	1.2.3.4	x	u	x=[ABC] ∧ u=1
~~1.2.3.4~~	~~x~~	~~v~~	~~x=[ABC] ∧ x=[AC] ∧ v=1~~	
~~y~~	~~z~~	~~u~~	~~y=1.2.3.4 ∧ y≠1.2.3.4 ∧ z=[ABC] ∧ u=1~~	
y	z	u	y=5.6.7.8 ∧ z=[ABC] ∧ u≠1	
~~y~~	~~z~~	~~v~~	~~y=1.2.3.4 ∧ y≠1.2.3.4 ∧ z=[AC] ∧ v=1~~	
y	z	v	y=5.6.7.8 ∧ z=[AC] ∧ v≠1	

sequential application of P_1 and P_2.

○:contradictory

$P_1 \cup P_3$

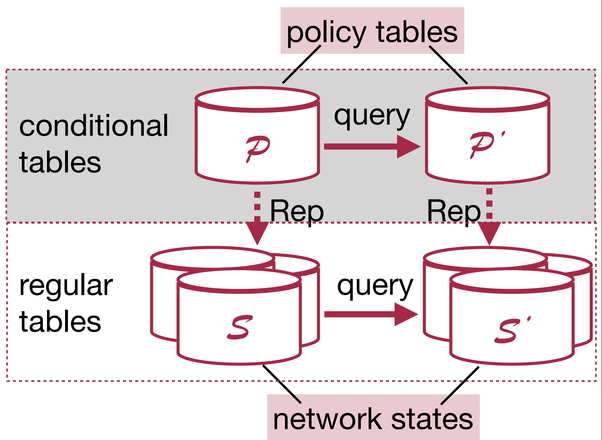
$P_1 \cup P_3$	dest	path	
	1.2.3.4	x	x=[ABC] ∨ x=[ADC]
	y	z	y≠1.2.3.5∧y≠1.2.3.4

both P_1 and P_3 are permitted.

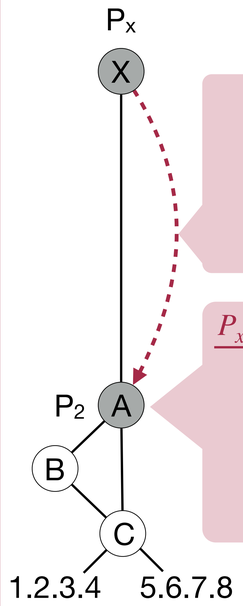
Idea: Policy as Conditional Table

A conditional table can:

- represent a network policy: $\mathcal{P}$, $\mathcal{P}'$.
- transform policy: SQL query.



Policy Exchange



P_X	dest	path	
	1.2.3.4	x	I(x)⩽2
P_X'	dest	path	
	1.2.3.4	x	I(x)⩽1

Transform — Propagation

$P_x' \bowtie P_2$	dest	flag	path	
	1.2.3.4	u	[ABC]	u=1∧I(ABC)⩽1
	1.2.3.4	v	[AC]	v=1∧I(AC)⩽1
	5.6.7.8	u	[ABC]	u≠1
	5.6.7.8	v	[AC]	v≠1

Merging

Relational Algebra

Support full set of relational operators{π, σ, $\bowtie$, $\cup$, $-$, ρ}.

$\pi_{dest,path}(P_2)$

dest	path
1.2.3.4	[ABC]
1.2.3.4	[AC]

Focus on attributes dest and path.

π: project ∪: union
σ: select $-$: difference
$\bowtie$: join ρ: rename

$\sigma_{dest=1.2.3.4}(P_2)$

dest	path	flag	
1.2.3.4	[ABC]	u	u=1
1.2.3.4	[AC]	v	v=1

Query all alternative routes for 1.2.3.4.

$P_2 - (P_x' \bowtie P_2)$

dest	path	flag	
1.2.3.4	[ABC	u	u=1
1.2.3.4	[AC]	v	v=1

Differences between P_2 and new policy $(P_x' \bowtie P_2)$.

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